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Section 21
Piping Integrity

Underground pipes used to transport waste hotline coolant at the facility were tested for integrity during the 1997 RFI. The locations of the pipes tested during the RFI are shown in Figure 21-1. Table 21-1 lists the pipes that were tested. These pipes were used intermittently, and were pressurized only when in use.

21.1 Pipe Testing Method

The pipes tested for the RFI were no longer in service at the time of testing. Several of the pipes had been taken out of service when the new wastewater ultrafiltration system was installed in 1997. The line from Tank 1 to the Tank Farm was separated into two sections for the test. The pipes were tested at their normal operating pressure by filling them with water. After 1 hour, the pressure was recorded, then the amount of water required to return the system to its operating pressure was measured. This process was then repeated.

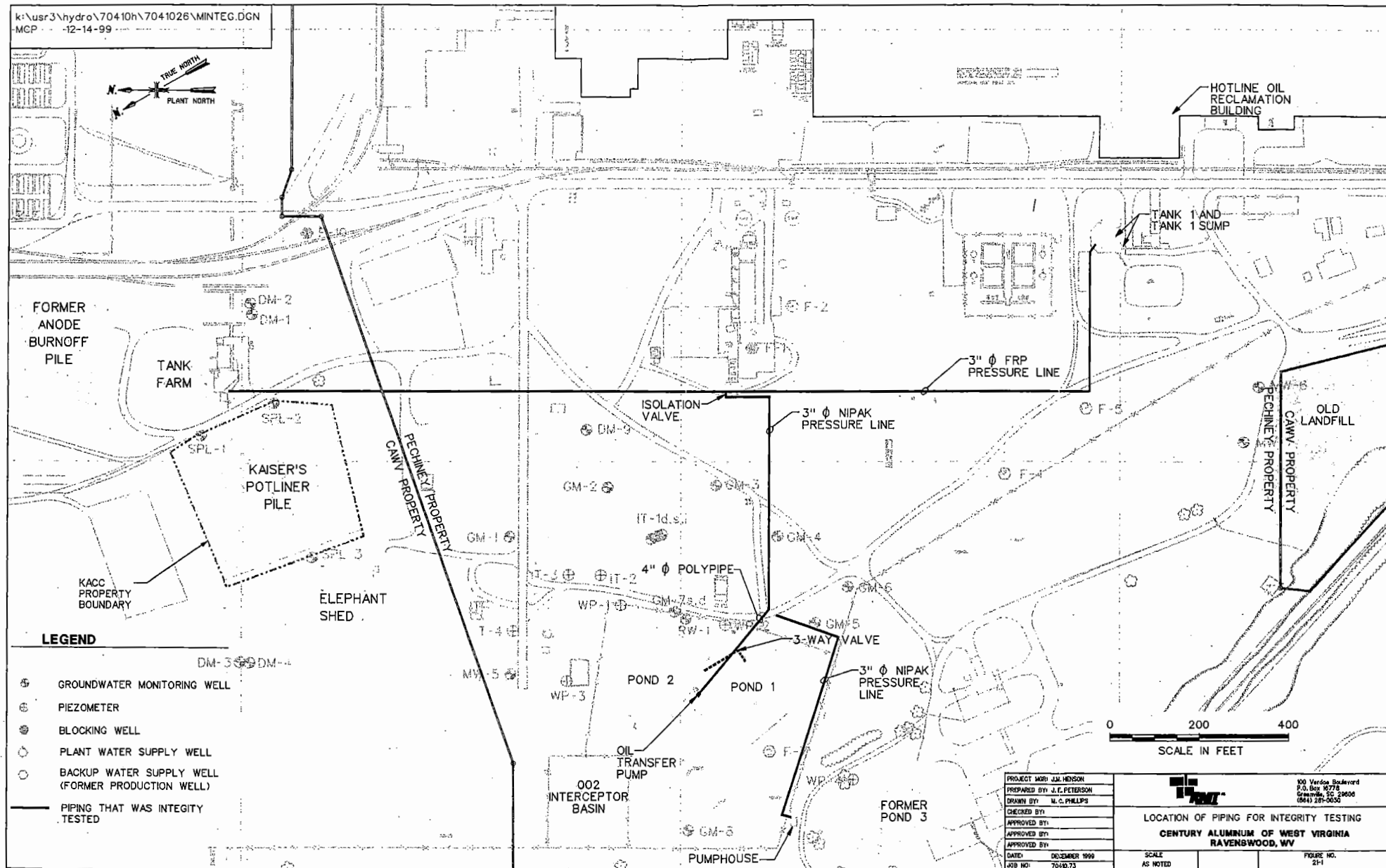## 21.2 Pipe Testing Results

Table 21-2 summarizes the results of pressure testing. The first two pipes that were tested had a greater amount of water required to regain the operating pressure during the first hour than during the second hour. The interpretation of this is that the air in the line was not completely removed for the first test, so the second test is considered to be the truer measure of potential releases from the pipe.

To interpret the test results, the allowable leakage rates for newly installed pressure pipes of the same dimensions were calculated and compared to the test results. For each pipeline, the leakage rate determined from testing was less than the reference rate for new pipes.

21.3 Summary of Findings for Pipe Testing

- Test results were within acceptable limits.
- No further action is warranted.

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-MCP -12-14-99

TRUE NORTH
N
PLANT NORTH

HOTLINE OIL
RECLAMATION
BUILDING

FORMER
ANODE
BURNOFF
PILE

TANK
FARM

DM-2
DM-1

F-2

TANK 1 AND
TANK 1 SUMP

3" φ FRP
PRESSURE LINE

ISOLATION
VALVE

3" φ NIPAK
PRESSURE LINE

SPL-2
SPL-1

KAISER'S
POTLINER
PILE

PECHINEY PROPERTY
CAWV PROPERTY

DM-9

F-5

CAWV PROPERTY
PECHINEY PROPERTY

OLD
LANDFILL

GM-2

IT-1d.s.

F-4

GM-1

GM-3

GM-4

KACC
PROPERTY
BOUNDARY

SPL-3

ELEPHANT
SHED

4" φ POLYPIPE

GM-6

IT-2
IT-2

GM-7d.s.

WP-1

GM-5

RW-1
WP-2

3-WAY VALVE

3" φ NIPAK
PRESSURE
LINE

T-4

LEGEND

DM-3 DM-4

MW-5

WP-3

POND 2

POND 1

OIL
TRANSFER
PUMP

F-3

GROUNDWATER MONITORING WELL

PIEZOMETER

BLOCKING WELL

PLANT WATER SUPPLY WELL

BACKUP WATER SUPPLY WELL
(FORMER PRODUCTION WELL)

PIPING THAT WAS INTEGITY
TESTED

002
INTERCEPTOR
BASIN

GM-8

WP-4

FORMER
POND 3

PUMPHOUSE

0   200   400
SCALE IN FEET

PROJECT MGR: J.M. HENSON
PREPARED BY: J.E. PETERSON
DRAWN BY: M.C. PHILLIPS
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LOCATION OF PIPING FOR INTEGRITY TESTING
CENTURY ALUMINUM OF WEST VIRGINIA
RAVENSWOOD, WV

DATE: DECEMBER 1999
JOB NO: 70410.73

SCALE
AS NOTED

FIGURE NO.
21-1

Table 21-1
Pipes Tested for Integrity

DESCRIPTION	MATERIAL(S) OF CONSTRUCTION	DIAMETER (inches)	FLUID	APPROXIMATE LENGTH (feet)
Line from Pond 3 pumphouse terminating east of Pond 2	High density polyethylene (HDPE)	3	Recovered oil	600
Line from oil transfer pump to valve at Tank 1 - Tank Farm transfer line	Polypipe/ HDPE	4 and 3	Recovered oil	850
Southern half of line from Tank 1 to Tank Farm	Fiberglass reinforced plastic (FRP)	3	Oil/water emulsion	1,180
Northern half of line from Tank 1 to Tank Farm	FRP	3	Oil/water emulsion or Recovered oil	1,120

Table 21-2
Summary of Integrity Testing Results

DESCRIPTION	FIRST HOUR LOSS (gallons)	SECOND HOUR LOSS (gallons)	NEW PIPE INSTALLATION STANDARD	PASS/FAIL
Line from Pond 3 pumphouse terminating east of Pond 2	0.08	0	0.5	Pass
Line from oil transfer pump to valve at Tank 1 - Tank Farm transfer line	0.8	0.1	0.8	Pass
Southern half of line from Tank 1 to Tank Farm	0	0	1.1	Pass
Northern half of line from Tank 1 to Tank Farm	0	0	1.1	Pass

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Section 22
Human Health Risk Assessment

This risk assessment is provided to characterize the nature and magnitude of potential risks to human health caused by constituents of concern present in site soil at concentrations above the generic industrial screening levels. The risk assessment was performed according to the methods described in *Risk Assessment Guidance for Superfund (RAGS); Human Health Evaluation Manual Part A* (USEPA, 1989). The risk assessment approach was discussed with USEPA in a conference call on July 21, 1998, and confirmed in correspondence dated July 24, 1998.

22.1   Identification of Constituents of Potential Concern

The soil data collected during the 1995 and 1997 RCRA Facility Investigations were compared to generic industrial screening concentrations as described in Section 3 of this RFI Report. As requested by USEPA, data collected during the RCRA Facility Assessment were also compared to the industrial screening concentrations. No exceedences were identified. This risk assessment addresses, for each area of investigation, constituents for which observed concentrations exceeded generic industrial screening concentrations. The data collected for each area of investigation is discussed in detail in Section 4 through Section 16 of this RFI Report. Table 22-1 summarizes the constituents of potential concern for each area of investigation.

The constituents of concern for each area are PAHs. PAHs are commonly detected in urban and industrial areas not directly affected by any specific industrial process. In remote areas, total PAH concentrations of 0.2 mg/kg have been detected, while concentrations of 4 mg/kg to 8 mg/kg have been detected in samples collected near a busy highway. PAH concentrations as high as 130 mg/kg have been detected in ordinary road dust (US DHHS, 1993). Thus, the PAH concentrations used in this risk assessment may, in part, be due to factors other than industrial processes at the site.

22.2   Exposure Assessment

The objective of the exposure assessment is to estimate the type and magnitude of potential exposures to constituents of potential concern at the site. The exposures assessment for the site was developed in accordance with the guidance in RAGS (USEPA, 1989) and follows these steps:

1. Characterization of the exposure setting

2. Identification of exposure pathways

3. Quantification of exposure

Each area of the site is located within the industrialized portion of the CAWV facility. Current and potential future land use for each area has been identified as industrial, as discussed in Section 3 of this RFI Report. Because the areas of the site subject to this risk assessment are separate and isolated portions of the larger site, each area is considered separately for exposure settings and potential current and future exposure pathways. A potentially completed exposure pathway has the following four elements: constituent source, mechanism for release of the constituent, environmental transport medium, and feasible route of potential exposure. In each case, the constituent source and transport medium is soil. Table 22-2 summarizes the potentially completed exposure pathways for the site.

Area 2 encompasses approximately ½ acre of property adjacent to the Ohio River. It had previously been used from 1963 to 1970 to accumulate and load spent potliner onto barges. One sample, at a depth of 5 to 7 feet below land surface, had a benzo(a)pyrene concentration above the industrial screening concentration. The sample contained debris (cinder, asphalt, carbon, and wood), which is likely the source of the detected PAHs. The area is within the 100-year flood plain of the Ohio River and is not suitable for routine industrial use. The exposure scenario most reasonable for this area is construction, as it is feasible that a short duration construction project may be conducted in the area some time in the future that extends to the depth that benzo(a)pyrene was detected.

Area 5 includes several distinct sections: the tank farm, the railroad loadout area, and the anode burnoff area. Of these, the drainage depression portion of the anode burnoff area (with an area of approximately two-thirds of an acre) had several PAHs detected at concentrations above their industrial screening concentrations. The PAH concentrations exceeding screening levels were located in surface soils at the time of RFI field sampling. However, the drainage depression was later backfilled during a storm water management project. The soils with PAH concentrations above screening levels are now located at least 5 feet below land surface. Routine industrial use of this area will not result in exposure to these soils. Therefore, the exposure scenario most reasonable for this area is construction.

Area 7 is an engineered conveyance that is a part of an NPDES-permitted discharge system. Several PAHs were detected in conveyance sediments at concentrations above their respective industrial screening levels. There is no routine exposure to the conveyance. However, it is expected that occasional, non-routine maintenance will be conducted in the conveyance. The non-routine maintenance is modeled in this risk assessment as a construction exposure scenario.

Area 13 encompasses about 62 acres of land at the northern end of the CAWV facility. Several PAHs have been detected in surface soil at concentrations above their respective industrial screening concentrations. Area 13 has been subdivided into several potential use areas for this risk assessment. Approximately 48 acres of the area are located outside the facility fence and are potentially accessible to site trespassers. The remaining 14 acres of the area are within the facility fence. The railroad spur that was used to bring solid pitch to the facility and the solid pitch unloading area itself occupy about 3 acres of the area within the fence. The area outside the fence has potential exposure to trespassers, current industrial workers who mow the field during the summer months, future industrial workers, and construction workers. The area inside the fence has potential exposure to construction workers and current and future industrial workers. The area in the immediate vicinity of the railroad track also has potential exposure to current and future industrial workers or construction workers.

Area 14 is less than one-tenth of an acre in size and is located adjacent to the oil ponds in Area 6. Benzo(a)pyrene was detected in one debris sample from the area at a concentration above its industrial screening concentration. Current use of the area makes exposure unlikely except during construction projects (the area was discovered during installation of a pipeline). Future industrial use of the area is also feasible.

In addition to direct contact with affected soil, it is feasible that constituents of potential concern could be transported off site via the air pathway. This exposure scenario is modeled as a nearby residence in the prevailing downwind direction from the site. The exposure pathway for this scenario is inhalation.

Exposure concentrations are calculated separately for each area. Except when determined to be normally distributed using the Wilk-Shapiro W-test for goodness-of-fit, the constituent concentrations were assumed to be lognormally distributed. The exposure concentration is calculated as the 95 percent upper confidence limit of the arithmetic mean of the relevant data, or the maximum observed concentration if the calculated upper confidence limit exceeds the maximum detected concentration for the constituent. Detailed information about the calculation of exposure concentrations is provided in Appendix P. Table 22-3 summarizes the exposure concentrations used in the risk assessment. Data from nearby sampling locations in Area 10 and Area 1 were included in the calculation of industrial use and construction exposure for Area 13. Data from Area 6 were included in the calculation of industrial use and construction exposure for Area 14.

Chronic daily intake (CDI) is exposure to a constituent expressed as the mass of a substance contacted per unit body weight per unit time, averaged over a period of years. The CDIs for the constituents of potential concern at the site were calculated using the exposure equations, and, where applicable, recommended default exposure assumptions presented in RAGS (USEPA, 1989). The intake calculations and listed exposure assumptions for the various exposure scenarios are provided in Appendix P-1. Standard default values were used for several variables, and for the future industrial and residential scenarios. Site-specific variables included exposure frequency for construction, current workers, and trespassers, and the amount of skin surface likely exposed. The calculated CDIs for each constituent of potential concern for each area are summarized in Appendix P-4.

22.3 Toxicity Assessment

There are two purposes of the toxicity assessment: first, to review available information on the potential adverse effects that may result from exposure to the constituents of potential concern; and second, to quantify the relationship between exposure to these constituents and the likelihood of potential health effects. Toxicity reference values for the constituents of potential concern were taken from Integrated Risk Information System (IRIS) and NCEA provisional values as presented in the Region III RBC Table.

A constituent of potential concern may be considered in a risk assessment for carcinogenic effects, noncarcinogenic effects, or both. The constituents at the site that exceed generic industrial screening concentrations are carcinogenic PAHs. Toxicity values for constituents with potential carcinogenic effects are expressed as slope factors (SF). The SF is the upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime. It is the value used to define the probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. Table 22-4 lists the available carcinogenicity information for the carcinogenic constituents of potential concern at the site.

Table 22-4 also shows the USEPA Weight of Evidence (WOE) for each of the potentially carcinogenic constituents of potential concern at the site. WOE is a classification system for characterizing the extent to which the available data indicated that an agent is a human carcinogen. Group A chemicals are listed as "known human carcinogens" by USEPA. Group B1 chemicals are listed as "probable human carcinogens" based on limited evidence of carcinogenicity in humans. Group B2 chemical are called "probable human carcinogens" based on evidence if carcinogenicity in animals; human evidence is inadequate. Group C chemicals are "possible human carcinogens" based on limited evidence of carcinogenicity in animals; human evidence is inadequate. Group D chemicals are not classifiable as to human carcinogenicity. Group E chemicals show evidence of non-carcinogenicity in humans. Class A and Class B carcinogenic constituents of potential concern are presented in Table 22-5.

Slope factors are calculated based on toxicity testing that generally involves ingestion of the constituent being evaluated. It has been recognized that many constituents are not absorbed 100 percent through the gastrointestinal system. To apply oral toxicity values to dermal exposure, it is necessary to apply a dermal correction factor to slope factors when they are applied to absorbed intake values. The dermal correction factor for carcinogenic PAHs is 2 (ASTDR, *Toxicological Profile for Polycyclic Aromatic Hydrocarbons*, October 1989).

22.4   Risk Characterization

In the risk characterization, the results of the toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of risk for carcinogens. According to the guidance in RAGS (USEPA, 1989), the risk characterization is complete only when the numerical expressions of risk are accompanied by explanatory text interpreting and qualifying the results. The risk characterization for this assessment follows these guidelines and is presented below.

Risks for individual constituents are calculated by multiplying the CDI (mg/kg·day) by the SF (mg/kg·day)$^{-1}$ to give a unitless chemical-specific risk. Chemical-specific risks that are the result of the same exposure route are summed to give the pathway risk; and if multiple pathways exist, appropriate pathway risks are summed resulting in the total carcinogenic risk for a population.

Incremental carcinogenic risks for each constituent and each pathway are presented in Table 22-5. Total incremental risks for each exposure scenario are summarized in Table 22-6. The total incremental risk of 9.4×10^{-8} for Area 2 is a summation of pathway risks for ingestion, absorption, and inhalation of soil based on a construction exposure scenario. The total incremental risk of 9.2×10^{-7} for Area 5 is a summation of pathway risks for ingestion, absorption, and inhalation of soil based on a construction exposure scenario. The total incremental risk of 5.6×10^{-7} for Area 7 is a summation of pathway risks for ingestion, absorption, and inhalation of soil based on a construction exposure scenario. Area 14 has two exposure scenarios: construction and future industrial use. Each scenario includes the ingestion absorption, and inhalation pathways for soil. The total incremental risk for the construction scenario is 7.4×10^{-9}, and the total incremental risk for the future industrial use scenario is 1.7×10^{-6}. Area 13 has five exposure scenarios: current industrial use, future industrial use, railroad track area industrial use, construction, and trespasser. The total incremental risk for the current industrial use scenario is 5.4×10^{-6}, the total incremental risk for the future industrial use scenario is 1.8×10^{-4}, the total incremental risk for the railroad track area industrial use scenario is 2.7×10^{-5}, the total incremental risk for the construction scenario is 7.7×10^{-7}, and the total incremental risk for the trespasser scenario is 3.0×10^{-6}. The total incremental risk for off-site residents by the inhalation pathway is 7.8×10^{-12}.

USEPA has established a range of 10^{-4} to 10^{-6} as acceptable maximum limits for excess lifetime carcinogenic risks. The total incremental risks estimated for the future industrial use scenario in Area 13 exceed this range. The remaining exposure scenarios fall within the acceptable range of incremental risk. Therefore, unacceptable levels of increased carcinogenic risk may occur if industrial workers were exposed to Area 13 soils at the frequency and duration assumed in the risk calculation.

The calculated exposure concentration for future industrial use in Area 13 is highly influenced by the sample collected at SB-1302. Excluding this "hot-spot" sample from the calculation of the exposure concentration reduces the total incremental risk for future industrial use to 6.4×10^{-5}, which is within the acceptable range of incremental risk. This suggests that an interim measure targeting the vicinity of SB-1302, such as soil removal to a risk-based level, would reduce incremental risk to an acceptable level.

22.5 Uncertainty Analysis

The primary goal of the uncertainty analysis is to provide a discussion of the key assumptions made in the risk assessment that may significantly influence the estimate of risk. Uncertainty is inherent in the principle components of the risk assessment. A discussion of the sources of uncertainty contributing to the risk and the associated effects (overestimation or underestimation of risk) of these factors is presented in this section.

In the absence of empirical or site-specific data, assumptions are developed based on best estimates of exposure or dose-response relationships. To assist in the development of these estimates, USEPA recommends the use of guidelines and standard factors in risk assessments to promote consistency among risk assessments where assumptions must be made. Although the use of standard factors undoubtedly promotes comparability, their usefulness in accurately predicting risk is directly proportional to their applicability to the actual site-specific conditions.

The carcinogenic risk estimates for the site are based on a number of assumptions that incorporate varying degrees of uncertainty resulting from many sources, including the following:

- Environmental monitoring and data evaluation
- Assumptions in the selection of exposure pathways and scenarios
- Assumptions in the expression of carcinogenic risk

Table 22-7 summarizes the assumptions of the risk assessment that affect the estimates of exposure and risk. In general, the assumptions of the exposure and risk assessments result in overestimates of exposure and risk. Therefore, the risk estimates are likely to be greater than actual risks. Despite these uncertainties, the risk estimates summarized in Table 22-5 conform to USEPA guidance provided in RAGS (USEPA, 1989).

Table 22-1
Summary of Constituents of Potential Concern by Area

AREA	CONSTITUENTS OF POTENTIAL CONCERN
Area 1	None
Area 2	Benzo(a)pyrene
Area 3	None
Area 4	None
Area 5	Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene
Area 6	None
Area 7	Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene
Area 8	none
Area 9	none
Area 11	none
Area 12	none
Area 13	Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(g,h,i)perylene
Area 14	Benzo(a)pyrene

Table 22-2
Potentially Completed Exposure Pathways

AREA	SCENARIO	PATHWAY
Area 2	Construction	Ingestion, Absorption, Inhalation
Area 5	Construction	Ingestion, Absorption, Inhalation
Area 7	Construction	Ingestion, Absorption, Inhalation
Area 13	Current industrial worker	Ingestion, Absorption, Inhalation
	Future industrial worker	Ingestion, Absorption, Inhalation
	Railroad area worker	Ingestion, Absorption, Inhalation
	Construction	Ingestion, Absorption, Inhalation
	Trespasser	Ingestion, Absorption, Inhalation
Area 14	Future industrial worker	Ingestion, Absorption, Inhalation
	Construction	Ingestion, Absorption, Inhalation
Off-site	Residential	Inhalation

Table 22-3
Summary of Exposure Concentrations

AREA/MEDIA	RECEPTOR	CONSTITUENT	SOIL CONCENTRATION (mg/kg)
Area 2 - Soil	Construction worker	Benzo(a)pyrene	3.4
Area 5 - Soil	Construction worker	Benzo(a)anthracene	21
		Benzo(a)pyrene	27
		Benzo(b)fluoranthene	18
		Indeno(1,2,3-cd)pyrene	23
Area 7 - Soil	Construction worker	Benzo(a)anthracene	9.6
		Benzo(a)pyrene	9.8
		Benzo(b)fluoranthene	4.8
		Dibenz(a,h)anthracene	9.2
Area 14 - Soil	Future industrial worker Construction worker	Benzo(a)pyrene	0.27
Area 13 - Soil	Current industrial worker Future industrial worker Construction worker	Benzo(a)anthracene	11
		Benzo(b)fluoranthene	19
		Benzo(k)fluoranthene	13
		Benzo(a)pyrene	21
		Indeno(1,2,3-cd)pyrene	11
		Dibenz(a,h)anthracene	2.8
		Benzo(g,h,i)perylene	12
Area 13 - Railroad area surface soil	Railroad area worker	Benzo(a)anthracene	380
		Benzo(b)fluoranthene	390
		Benzo(k)fluoranthene	360
		Benzo(a)pyrene	520
		Indeno(1,2,3-cd)pyrene	360
		Dibenz(a,h)anthracene	250
		Benzo(g,h,i)perylene	390
Area 13 - Surface soil	Trespasser	Benzo(a)anthracene	9.3
		Benzo(b)fluoranthene	16.3
		Benzo(k)fluoranthene	18
		Benzo(a)pyrene	24
		Indeno(1,2,3-cd)pyrene	7.2
		Dibenz(a,h)anthracene	4.2
		Benzo(g,h,i)perylene	6.9

Table 22-3
Summary of Exposure Concentrations

AREA/MEDIA	RECEPTOR	CONSTITUENT	SOIL CONCENTRATION (mg/kg)
Sitewide - Surface soil	Off-site residents	Benzo(a)anthracene	12
		Benzo(b)fluoranthene	23
		Benzo(k)fluoranthene	19
		Benzo(a)pyrene	30
		Indeno(1,2,3-cd)pyrene	14
		Dibenz(a,h)anthracene	4
		Benzo(g,h,i)perylene	16

Table 22-4
Toxicity Values: Potential Carcinogenic Effects

CHEMICAL	ORAL SLOPE FACTOR (mg/kg·day)	WOE CLASS [1]	TYPE OF CANCER	SLOPE FACTOR SOURCE
Benzo(a)anthracene	7.3×10^{-1}	B2	Hepatoma, pulmonary adenoma	USEPA-NCEA
Benzo(b)fluoranthene	7.3×10^{-1}	B2	Hepatoma	USEPA-NCEA
Benzo(k)fluoranthene	7.3×10^{-2}	B2	Lung adenoma	USEPA-NCEA
Benzo(a)pyrene	7.3×10^{-0}	B2	Squamous cell carcinoma	IRIS
Indeno(1,2,3-cd)pyrene	7.3×10^{-1}	B2	Epidermoid carcinoma	USEPA-NCEA
Dibenz(a,h)anthracene	7.3×10^{-0}	B2	Pulmonary carcinoma	USEPA-NCEA
Benzo(g,h,I)perylene	7.3×10^{-1}	D		USEPA-NCEA
CHEMICAL	**INHALATION SLOPE FACTOR (mg/kg·day)**	**WOE CLASS [1]**	**TYPE OF CANCER**	**SLOPE FACTOR SOURCE**
Benzo(a)anthracene	3.1×10^{-1}	NA	NA	[2]
Benzo(b)fluoranthene	3.1×10^{-1}	NA	NA	[2]
Benzo(k)fluoranthene	3.1×10^{-2}	NA	NA	[2]
Benzo(a)pyrene	3.1×10^{-0}	NA	NA	USEPA-NCEA
Indeno(1,2,3-cd)pyrene	3.1×10^{-1}	NA	NA	[2]
Dibenz(a,h)anthracene	3.1×10^{-0}	NA	NA	[2]

[1]   Weight of Evidence
[2]   Based on benzo(a)pyrene using the same toxicity equivalency factor as oral slope factors

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Table 22-5

Estimated Incremental Carcinogenic Risks

</div>

EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Area 2 - Construction				
Ingestion	Benzo(a)pyrene	5.2×10^{-8}	5.2×10^{-8}	
Absorption	Benzo(a)pyrene	4.2×10^{-8}	4.2×10^{-8}	
Inhalation	Benzo(a)pyrene	7.4×10^{-11}	7.4×10^{-11}	
Total				9.4×10^{-8}
Area 5 - Construction				
Ingestion	Benzo(a)anthracene Benzo(b)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene	3.2×10^{-8} 2.8×10^{-8} 4.1×10^{-7} 3.5×10^{-8}		
Subtotal			5.1×10^{-7}	
Absorption	Benzo(a)anthracene Benzo(b)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene	2.6×10^{-8} 2.2×10^{-8} 3.3×10^{-7} 2.8×10^{-8}		
Subtotal			4.1×10^{-7}	
Inhalation	Benzo(a)anthracene Benzo(b)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene	1.2×10^{-10} 2.1×10^{-10} 5.9×10^{-10} 5.7×10^{-11}		
Subtotal			9.7×10^{-10}	
Total				9.2×10^{-7}
Area 7 - Construction				
Ingestion	Benzo(a)anthracene Benzo(b)fluoranthene Benzo(a)pyrene Dibenz(a,h)anthracene	1.5×10^{-8} 7.4×10^{-9} 1.5×10^{-7} 1.4×10^{-7}		
Subtotal			3.1×10^{-7}	

Table 22-5
Estimated Incremental Carcinogenic Risks

EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Absorption	Benzo(a)anthracene	1.2×10^{-8}		
	Benzo(b)fluoranthene	5.9×10^{-9}		
	Benzo(a)pyrene	1.2×10^{-7}		
	Dibenz(a,h)anthracene	1.1×10^{-7}		
Subtotal			2.5×10^{-7}	
Inhalation	Benzo(a)anthracene	5.4×10^{-11}		
	Benzo(b)fluoranthene	4.5×10^{-11}		
	Benzo(a)pyrene	2.1×10^{-10}		
	Dibenz(a,h)anthracene	5.0×10^{-11}		
Subtotal			3.7×10^{-10}	
Total				5.6×10^{-7}
Area 14 - Construction				
Ingestion	Benzo(a)pyrene	4.1×10^{-9}	4.1×10^{-9}	
Absorption	Benzo(a)pyrene	3.3×10^{-9}	3.3×10^{-9}	
Inhalation	Benzo(a)pyrene	5.9×10^{-12}	5.9×10^{-12}	
Total				7.4×10^{-9}
Area 14 - Future Industrial				
Ingestion	Benzo(a)pyrene	3.4×10^{-7}	3.4×10^{-7}	
Absorption	Benzo(a)pyrene	1.4×10^{-6}	1.4×10^{-6}	
Inhalation	Benzo(a)pyrene	2.5×10^{-9}	2.5×10^{-9}	
Total				1.7×10^{-6}
Area 13 - Current Industrial				
Ingestion	Benzo(a)anthracene	4.2×10^{-8}		
	Benzo(b)fluoranthene	7.3×10^{-8}		
	Benzo(k)fluoranthene	5.0×10^{-9}		
	Benzo(a)pyrene	8.0×10^{-7}		
	Indeno(1,2,3-cd)pyrene	4.2×10^{-8}		
	Dibenz(a,h)anthracene	1.1×10^{-7}		
Subtotal			1.1×10^{-6}	

Table 22-5
Estimated Incremental Carcinogenic Risks

EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Absorption	Benzo(a)anthracene	1.7×10^{-7}		
	Benzo(b)fluoranthene	2.9×10^{-7}		
	Benzo(k)fluoranthene	2.0×10^{-8}		
	Benzo(a)pyrene	3.2×10^{-6}		
	Indeno(1,2,3-cd)pyrene	1.7×10^{-7}		
	Dibenz(a,h)anthracene	4.3×10^{-7}		
Subtotal			4.3×10^{-6}	
Inhalation	Benzo(a)anthracene	7.3×10^{-10}		
	Benzo(b)fluoranthene	2.7×10^{-9}		
	Benzo(k)fluoranthene	2.4×10^{-11}		
	Benzo(a)pyrene	5.7×10^{-9}		
	Indeno(1,2,3-cd)pyrene	3.4×10^{-10}		
	Dibenz(a,h)anthracene	1.9×10^{-10}		
Subtotal			9.8×10^{-9}	
Total				5.4×10^{-6}
Area 13 - Future Industrial				
Ingestion	Benzo(a)anthracene	1.4×10^{-6}		
	Benzo(b)fluoranthene	2.4×10^{-6}		
	Benzo(k)fluoranthene	1.7×10^{-7}		
	Benzo(a)pyrene	2.7×10^{-5}		
	Indeno(1,2,3-cd)pyrene	1.4×10^{-6}		
	Dibenz(a,h)anthracene	3.6×10^{-6}		
Subtotal			3.6×10^{-5}	
Absorption	Benzo(a)anthracene	5.6×10^{-6}		
	Benzo(b)fluoranthene	9.7×10^{-6}		
	Benzo(k)fluoranthene	6.6×10^{-7}		
	Benzo(a)pyrene	1.1×10^{-4}		
	Indeno(1,2,3-cd)pyrene	5.6×10^{-6}		
	Dibenz(a,h)anthracene	1.4×10^{-5}		
Subtotal			1.4×10^{-4}	

Table 22-5
Estimated Incremental Carcinogenic Risks

EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Inhalation	Benzo(a)anthracene	2.6×10^{-8}		
	Benzo(b)fluoranthene	9.0×10^{-8}		
	Benzo(k)fluoranthene	7.5×10^{-10}		
	Benzo(a)pyrene	1.9×10^{-7}		
	Indeno(1,2,3-cd)pyrene	1.1×10^{-8}		
	Dibenz(a,h)anthracene	6.4×10^{-9}		
Subtotal			3.3×10^{-7}	
Total				1.8×10^{-4}
Area 13 - Railroad Area				
Ingestion	Benzo(a)anthracene	2.3×10^{-7}		
	Benzo(b)fluoranthene	2.4×10^{-7}		
	Benzo(k)fluoranthene	2.2×10^{-8}		
	Benzo(a)pyrene	3.2×10^{-6}		
	Indeno(1,2,3-cd)pyrene	2.2×10^{-7}		
	Dibenz(a,h)anthracene	1.5×10^{-6}		
Subtotal			5.4×10^{-6}	
Absorption	Benzo(a)anthracene	9.3×10^{-7}		
	Benzo(b)fluoranthene	9.6×10^{-7}		
	Benzo(k)fluoranthene	8.8×10^{-8}		
	Benzo(a)pyrene	1.3×10^{-5}		
	Indeno(1,2,3-cd)pyrene	8.8×10^{-7}		
	Dibenz(a,h)anthracene	6.1×10^{-6}		
Subtotal			2.2×10^{-5}	
Inhalation	Benzo(a)anthracene	4.3×10^{-9}		
	Benzo(b)fluoranthene	8.9×10^{-9}		
	Benzo(k)fluoranthene	9.9×10^{-11}		
	Benzo(a)pyrene	2.3×10^{-8}		
	Indeno(1,2,3-cd)pyrene	1.8×10^{-9}		
	Dibenz(a,h)anthracene	2.7×10^{-9}		
Subtotal			4.1×10^{-8}	
Total				2.7×10^{-5}

Table 22-5
Estimated Incremental Carcinogenic Risks

EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Area 13 - Construction				
Ingestion	Benzo(a)anthracene	1.7×10^{-8}		
	Benzo(b)fluoranthene	2.9×10^{-8}		
	Benzo(k)fluoranthene	2.0×10^{-9}		
	Benzo(a)pyrene	3.2×10^{-7}		
	Indeno(1,2,3-cd)pyrene	1.7×10^{-8}		
	Dibenz(a,h)anthracene	4.3×10^{-8}		
Subtotal			4.3×10^{-7}	
Absorption	Benzo(a)anthracene	1.4×10^{-8}		
	Benzo(b)fluoranthene	2.3×10^{-8}		
	Benzo(k)fluoranthene	1.6×10^{-9}		
	Benzo(a)pyrene	2.6×10^{-7}		
	Indeno(1,2,3-cd)pyrene	1.4×10^{-8}		
	Dibenz(a,h)anthracene	3.4×10^{-8}		
Subtotal			3.4×10^{-7}	
Inhalation	Benzo(a)anthracene	6.2×10^{-11}		
	Benzo(b)fluoranthene	2.2×10^{-10}		
	Benzo(k)fluoranthene	1.8×10^{-12}		
	Benzo(a)pyrene	4.6×10^{-10}		
	Indeno(1,2,3-cd)pyrene	2.7×10^{-11}		
	Dibenz(a,h)anthracene	1.5×10^{-11}		
Subtotal			7.8×10^{-10}	
Total				7.7×10^{-7}
Area 13 - Trespasser				
Ingestion	Benzo(a)anthracene	5.5×10^{-8}		
	Benzo(b)fluoranthene	9.6×10^{-8}		
	Benzo(k)fluoranthene	1.1×10^{-8}		
	Benzo(a)pyrene	1.4×10^{-6}		
	Indeno(1,2,3-cd)pyrene	4.2×10^{-8}		
	Dibenz(a,h)anthracene	2.5×10^{-7}		
Subtotal			1.9×10^{-6}	

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Table 22-5
Estimated Incremental Carcinogenic Risks

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EXPOSURE PATHWAY	CONSTITUENT	CONSTITUENT RISK	PATHWAY RISK	TOTAL RISK
Absorption	Benzo(a)anthracene	3.3×10^{-8}		
	Benzo(b)fluoranthene	5.7×10^{-8}		
	Benzo(k)fluoranthene	6.3×10^{-9}		
	Benzo(a)pyrene	8.5×10^{-7}		
	Indeno(1,2,3-cd)pyrene	2.5×10^{-8}		
	Dibenz(a,h)anthracene	1.5×10^{-7}		
Subtotal			1.1×10^{-6}	
Inhalation	Benzo(a)anthracene	1.5×10^{-10}		
	Benzo(b)fluoranthene	5.4×10^{-10}		
	Benzo(k)fluoranthene	7.1×10^{-12}		
	Benzo(a)pyrene	1.5×10^{-9}		
	Indeno(1,2,3-cd)pyrene	5.1×10^{-11}		
	Dibenz(a,h)anthracene	6.6×10^{-11}		
Subtotal			2.3×10^{-9}	
Total				3.0×10^{-6}
Off-Site Resident				
Inhalation	Benzo(a)anthracene	6.9×10^{-13}		
	Benzo(b)fluoranthene	2.3×10^{-12}		
	Benzo(k)fluoranthene	1.1×10^{-12}		
	Benzo(a)pyrene	3.7×10^{-12}		
	Indeno(1,2,3-cd)pyrene	3.1×10^{-15}		
	Dibenz(a,h)anthracene	4.1×10^{-15}		
Subtotal			7.8×10^{-12}	
Total				7.8×10^{-12}

Table 22-6
Summary of Incremental Risk

AREA	SCENARIO	RISK
Area 2	Construction	9.4×10^{-8}
Area 5	Construction	9.2×10^{-7}
Area 7	Construction	5.6×10^{-7}
Area 13	Current Worker	5.4×10^{-6}
Area 13	Future Worker	1.8×10^{-4}
Area 13	Railroad Area Worker	2.7×10^{-5}
Area 13	Construction Worker	7.7×10^{-7}
Area 13	Trespasser	3.0×10^{-6}
Area 14	Construction	7.4×10^{-9}
Area 14	Future Worker	1.7×10^{-6}
Off-site	Residential	7.8×10^{-12}

Table 22-7
Uncertainties in the Risk Assessment

SOURCE OF UNCERTAINTY	EFFECT ON ESTIMATE OF EXPOSURE OR RISK
Data Collection and Evaluation	
Sampling generally concentrated in hot-spots.	Most likely overestimates exposure.
Detection level used when constituent not detected.	Most likely overestimates exposure.
Assumed log-normal distribution except when distribution was normal.	Most likely overestimates exposure.
Used 95% upper confidence level of arithmetic mean or highest detected concentration as exposure concentration for area.	Most likely overestimates exposure.
Exposure Pathways and Scenarios	
Assumed future worker would spend entire workday in affected area 250 days per year for 25 years.	Most likely overestimates exposure.
Assumed construction worker would spend 15 days within the affected area.	Most likely overestimates exposure.
Assumed worker would spend about one hour per month along the railroad tracks in Area 13 for 25 years.	Most likely overestimates exposure.
Assumed adolescent trespasser would spend 20 days per year at unfenced area of site.	Most likely overestimates exposure.
Assumed off-site resident would be directly downwind of site 24 hours per day, 350 days per year for 25 years.	Most likely overestimates exposure.
Used simple SCREEN air model that assumes the exposure point is always downwind.	Most likely overestimates exposure.
Assumed no vegetative cover although one is present.	Most likely overestimates exposure.

Table 22-7
Uncertainties in the Risk Assessment

SOURCE OF UNCERTAINTY	EFFECT ON ESTIMATE OF EXPOSURE OR RISK
Expression of Risk	
Conservative assumptions compounded in risk calculations.	Most likely overestimates risk.
Used low to medium confidence slope factors.	Most likely overestimates risk.
Used provisional inhalation slope factor for benzo(a)pyrene and applied oral toxicity equivalency factors to estimate inhalation slope factors for other PAHs.	Most likely overestimates risk.
Carcinogenicity based on animal studies extrapolated to humans.	Most likely overestimates risk.
Used upper bound slope factor estimates.	Most likely overestimates risk.
Assumed no threshold effects level for carcinogenicity.	Most likely overestimates risk.

Section 23
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